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ERGONOMIC WORKSITE ANALYSIS OF AN ARMY DENTAL CLINIC

US ARMY RESEARCH INSTITUTE
OF
ENVIRONMENTAL MEDICINE
Natick, Massachusetts

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The purposes of this worksite analysis were: (1) to identify the prevalance of cumulative trauma disorders (CTDs), associated symptoms and risk factors, with special attention to carpal tunnel syndrome (CTS), (2) to identify practitioners at risk, and (3) to offer suggestions for early identification and prevention of injuries, as needed. The worksite analysis of the Fort Leonard Wood, MO DENTAC, involved videotaping, photographing work stations, administering two questionnaires, reviewing medical records, and interviewing selected personnel. One or more symptoms indicative of CTS were noted by 75.6% of the dental workers and 11% reported diagnosed CTS. Although dental assistants expanded function (DAEFs) were found to be at greatest risk for development of upper extremity symptoms and carpal tunnel syndrome, each of the MOS groupings displayed a high percentage of hand/wrist symptoms. Back and shoulder pain was reported by 53% of the respondents. Psychosocial factors as well as physical risk factors were found to be associated with cumulative disorder symptoms. Suggestions for injury surveillance and prevention were offered.

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BACKGROUND

This project was conducted as a result of conversations between Mr. Glen Werner, U.S. Army Health Clinic, Fort Leonard Wood and Mr. John Pentikis, U.S. Army Environmental Hygiene Agency (USAEHA), July-August 1991, in discussing the notion that injury rates and musculoskeletal symptom reports of DENTAC personnel seemed unacceptably high. The purpose of the consultation was to identify risk factors associated with occupational cumulative trauma disorders (CTD), in particular carpal tunnel syndrome (CTS). The project was completed under Industrial Hygiene Consultation No. 54-71-R205-91, Ergonomic Evaluation of an Army Dental Clinic, Fort Leonard Wood, Missouri, 23-27 September 1991.

ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

The purposes of this Dental Clinic worksite analysis were: (1) to identify the prevalence of cumulative trauma disorders (CTDs), associated symptoms and risk factors, with special attention to carpal tunnel syndrome (CTS), (2) to identify practitioners at risk, and (3) to offer suggestions for early identification and prevention of injuries, as needed. The worksite analysis of the Fort Lenord Wood, MO DENTAC, involved videotaping, photographing work stations, administering two questionnaires, and interviewing selected personnel. One or more symptoms indicative of CTS were noted by 75.6% of the dental workers and 11% reported diagnosed CTS. Although practitioners classified as dental assistant-expanded function (DAEF) were found to be at greatest risk for development of upper extremity symptoms and carpal tunnel syndrome, each of the MOS groupings displayed a high percentage of hand/wrist symptoms. Back and shoulder pain was reported by 53% of the respondents. Psychosocial factors as well as physical risk factors were found to be associated with cumulative disorder symptoms. Suggestions for injury surveillance and prevention are offered.

INTRODUCTION

Cumulative trauma disorders (CTD) are occupationally related neuromuscular disorders caused by repeated biomechanical stress and micro-trauma. Over time, repeated micro-trauma can evolve into a painful, debilitating state and involve muscles, tendons, tendon sheaths, and nerves. Repetitive motions, forceful exertions, acceleration and velocity of dynamic motions, vibration, mechanical compression, sustained or awkward postures, extreme temperatures, and extended exposure to noise can contribute to the development of CTDs (Armstrong and Silverstein, 1987; Bammer and Blignault, 1987; Marras and Shoenmarklin, 1991; Putz-Anderson, 1988). Tendonitis, tenosynovitis, bursitis, chronic muscle strain, and nerve entrapment syndromes are examples of CTD's.

The U.S. Occupational Safety and Health Administration (OSHA) has reported a dramatic rise in CTDs and other work-related injuries due to ergonomic hazards. In August 1990, OSHA began a nationwide program to help decrease worker exposure to ergonomic hazards (OSHA, 1991). According to the 1988 report by the Bureau of Labor Statistics, CTDs account for 48% of work-related injuries in the private sector. A recent review of worker's compensation records revealed that reports have also increased for the U.S. Army (U.S. Army Safety Center, 1992). The expense is considerable in lost work time, medical treatment, rehabilitation, and diminished morale. The estimated workman's compensation cost for the Army, for one case of carpal tunnel syndrome (requiring surgery), is $10,000 (U.S. Army Safety Center, 1992).

Carpal tunnel syndrome (CTS) is the most commonly occurring upper extremity CTD. The base of the carpal tunnel, located in the wrist, is formed by eight carpal bones, while the roof is formed by the flexor retinaculum ligament. Eight flexor tendons, blood vessels, and the median nerve pass through the carpal tunnel. Tendon inflammation or swelling, or tendon sheath irritation with possible increase in production of synovial fluid, can result in crowding within the carpal tunnel. CTS, compression of the median nerve within the carpal tunnel, is often the result. Symptoms include numbness, paresthesia, pain, and

weakness over the thumb, index, middle, and half of the ring finger. Symptoms often interfere with both work and leisure activities.

Workplace factors are thought to be causative elements in 47% of all cases of CTS (Baker and Ehrenberg, 1990; Occupational disease surveillance, 1989). Occupations considered at risk for development of upper extremity CTDs (including CTS) include office workers, cashiers, assembly-line industries, meat-cutters, butchers, musicians, cooks, and dental hygienists (Fry, 1986; Huntley and Shannon, 1983; Jensen, Klein, and Sanderson, 1983; Nathan, Meadows, and Doyle, 1988; Paulozzi, Helgerson, and Apol, 1984).

Work-related musculoskeletal injuries or illnesses reported by dental hygienists include areas of the back, neck, shoulders, elbow, wrist, and hand, as well as varicose veins and eye strain (Boyer, Elton, and Preston, 1986; Macdonald, 1987; Shannon, 1984). Work-related back pain was reported in 44% of respondents in a 1977 survey in Hawaii (Gravois and Stringer, 1980). A study of Minnesota Dental Hygienists revealed that 7% had been diagnosed as having carpal tunnel syndrome, while 63% reported experiencing one or more symptoms associated with CTS (Osborn, Newell, Rudney, and Stoltenberg, 1990). Similar results were found among California Dental Hygienists, in which 6.4% of those surveyed had been diagnosed with CTS (Osborn, 1990).

With the decrease in the size of the military force, the emphasis must be on early identification and prevention of injuries. In addition, as costs associated with workers compensation escalate, occupational injuries must be identified, research conducted, and intervention strategies established to curb the increase in ergonomically related injuries. The purposes of this Dental worksite analysis were: (1) to identify the prevalence of CTDs, associated symptoms and risk factors, with special attention to CTS, (2) to identify dental practitioners at risk, and (3) to offer suggestions for early identification and prevention of injuries, as needed.

METHODOLOGY

The ergonomic worksite analysis of the Fort Leonard Wood, MO dental service involved five methods of collecting information; videotaping practitioners at work, photographing work stations, administering two questionnaires, reviewing medical records (to confirm reported diagnosis), and interviewing selected personnel. A team of four evaluators (one ergonomist/Occupational Therapist, one physician, and two industrial hygienists) collected the information during a site visit to the Ft. Lenord Wood DENTAC. All available, consenting dental workers participated.

VIDEOTAPE AND PHOTOGRAPHY

Three dentists, three dental assistants, and six dental assistants-expanded function were videotaped. Six locations were marked with reflective tape prior to filming (to permit range-of-motion measurements): ulnar aspect of the fifth digit metacarpophalangeal joint, ulnar styloid process, dorsum of the third digit metacarpophalangeal joint, natural depression in the capitate bone at the dorsal base of the third metacarpal, radial aspect of the second digit metacarpophalangeal joint, and the radial aspect of the radial styloid process. Nine hours of videotaping involving 13 dental employees were analyzed. A task analysis was conducted in which duration of hand grip used (power, pinch, retraction, other) and wrist position (ulnar deviation, radial deviation, neutral, flexion, extension, and other) were recorded. Number of repetitions of wrist movement were also recorded. Still photographs were taken of dental instruments, workstations, and dental procedures.

QUESTIONNAIRES

Forty-five employees of the dental clinic at Fort Leonard Wood, MO completed two questionnaires. All available, consenting employees completed the questionnaires. The first questionnaire was specifically developed for this survey. The second questionnaire was developed at Health Services

Command and was field tested during the survey at Fort Leonard Wood, MO. Participants were instructed to complete their questionnaires without discussing their response with other dental care workers. A member of the research team was present to respond to questions.

The questionnaires addressed demographic information including height, weight, age, marital status, gender, ethnicity, number of hours spent in leisure pursuits involving the prolonged upper extremity use, and handedness. Leisure (and work) activities evaluated included racquet sports, bowling, bicycling, building models, auto mechanics, knitting and other needle work, typing, work at a computer terminal, cooking, painting, and music. Subjects were also encouraged to list other applicable activities.

Work/occupational history included: identification of military occupational specialty (or comparable civilian identification); number of years worked in their military occupational specialty (MOS); number of patients treated per day; number of hours worked per week; percentage of time spent in patient care, laboratory work, administration, and other duties; level of job satisfaction, and level of control over their daily work routine. Information was also gathered regarding previous job(s), exposure to vibration, time spent conducting specific work tasks, sick leave, workers perception of whether their sick leave was related to their work duties, and limited duty assignments.

Symptoms commensurate with repetitive motion injuries were recorded. Participants responded to a list of potential symptoms by checking a block either yes or no. Finger, hand, and wrist symptoms included: numbness or tingling; pain at night; sensation of "falling asleep" during normal activity; stiffness; loss of strength; decreased sensation/loss of feeling; frequent dropping of objects; and morning swelling.

Participants identified specific work tasks which caused pain. The tasks included taking impressions, lip and cheek retraction, placing fillings, polishing teeth, preparing filling mixture, and scaling. Participants were asked to list other procedures which resulted in feelings of pain and which were not on our list.

Historical medical information included past hand or wrist injuries; arthritis or joint problems; back pain/strain; prior hand, wrist, or arm surgery; a history of repetitive trauma injury; and diagnosed carpal tunnel syndrome. Participants

perception of their general health was also recorded.

INTERVIEWS

Interviews were conducted to further clarify responses and illicit additional information regarding the dental environment. In addition, informal discussions were held with employees to allow them to voice concerns throughout the week long investigation.

STATISTICAL ANALYSIS

Categorical data were analyzed using the chi square statistic and risk ratios with Epi Info statistical software (Dean, Dean, Burton, and Dicker, 1990). The Fishers exact test was used for categorical data with a small cell n. Correlation coefficients (Pearson) were calculated for continuous variables using the Biomedical Data Processing Package (BMDP) statistical package 4F analysis of two-way frequency tables.

RESULTS

VIDEO TAPE ANALYSIS

The video tape analysis revealed high work/rest ratios for dentists, dental hygienists, and dental assistants-expanded function (DAEF) (Table 1). Duration of time spent in static postures and extreme ranges of motion are listed in Table 2.

QUESTIONNAIRES

The military occupational specialty (MOS) categories were combined into

four distinct categories, since there were insufficient numbers of practitioners in some categories to be statistically analyzed. The categories are: dentists; dental assistants; special assistants and dental hygienists (SA_HYG); and dental assistants-expanded function (DAEF). Dental assistants-expanded function do not exist outside of the military. Their job functions and the job functions of Dental Hygienists are listed in Appendix A. At the request of one of the educational coordinators for the Ft. Lenord Wood, MO DENTAC, the MOS categories were recombined into three categories: dentists, dental assistants and special assistants, and dental hygienists and dental assistants-expanded function. The results are included in Appendix B.

Demographics

Of the population surveyed, 79% were married and 21% were single (Figure 1a). Females comprised 67% of the population and males comprised 33% (Figure 1b). The MOS distribution can be seen in Figure 1c. The respondent population is described in Figures 2a-2c. More women (65.5%) than men (33.3%) reported experiencing back pain ($p = 0.04$, Table 3). Individuals weighing 150 lbs or less (76.4%) were 1.91 times more likely to report experiencing back pain than were individuals weighing over 150 lbs(40%) ($p = 0.02$, Table 4). None of the other demographic data were found to be related to the frequency of occurrence of CTS, number of hand/wrist symptoms, specific incidence of upper extremity symptoms, back/shoulder symptoms, or sick leave used in the last year.

Military Occupational Specialty

The results reveal that dental assistants-expanded function (DAEF's) are more likely than dentists to report a history of cumulative trauma disorder. As seen in Table 5, 62.5% of the DAEF's surveyed reported a history of CTD. The difference in the number of DAEF's and dentists reporting CTD is significant ($p < 0.01$) and DAEF's are 8.8 times more likely to have experienced cumulative trauma than were dentists. A greater number of DAEF's (77.7%) than dentists (14.2%) reported experiencing five or more symptoms associated with CTS ($p <$

0.007). DAEF's were 5.5 times more likely to have experienced five or more symptoms than were dentists (Table 5). Although the number of SA_HYG's experiencing five or more symptoms is greater than the number of dentists with five or more symptoms, the finding was not statistically significant. However, a trend may be indicated, as fifty percent reported experiencing five or more symptoms, and SA_HYG's are 3.5 times more likely to have reported five or more symptoms than are dentists (Table 5).

DAEF's were more likely to report hand and wrist symptoms of swelling, tingling, decreased sensation, pain at night, and the sensation of "falling asleep" during normal activity (Figure 3). Nearly sixty-seven percent of the DAEF's surveyed reported experiencing hand/wrist swelling and the difference in the number of DAEF's and dentists experiencing hand/wrist swelling is significant ($p < 0.005$, Table 6). DAEF's were 9.33 times more likely to report the symptom of swelling than were dentists. The risks of dental assistants and specialty assistants and hygienists were also greater than for dentists, although the difference was not statistically different.

Dentists (21.4%), dental assistants (35.7%), SA_HYG's (62.7%), and DAEF's (77.8%) reported experiencing tingling sensations in their fingers and/or hands. DAEF's reported this symptom 3.6 times more often than dentists ($p < 0.01$, Table 6).

DAEF's reported experiencing decreased sensation in their fingers and/or hands (55.6%) more often than dentists (14.3%) ($p < 0.05$, Table 6). According to these results, DAEF's are 3.5 and SA_HYG's are 3.9 times more likely to experience diminished sensation than are dentists.

DAEF's reported experiencing pain at night in their hands/fingers (77.8%) more often than did dentists or dental assistants (28.6%) ($p < 0.04$, Table 6). DAEF's were nearly 3 times more likely to experience pain at night than were dentists.

More DAEF's reported experiencing the sensation of their hands/fingers "falling asleep" (77.8%) than other MOS groupings and the difference in frequency from that reported by dentists (14.3%) is significant ($p < 0.006$, Table 6). Fifty percent of SA_HYGs and 28.6% of dental assistants also reported experiencing the sensation of their hands/fingers "falling asleep". DAEF's were 5.4 times more likely to experience the sensation of their hands/fingers falling

asleep than were dentists (Table 6).

DAEF's (55.6%), SA_HYG's (35.7%), and dental assistants (50%) reported frequent dropping of objects compared to no reports by dentists. Each of the findings were significant ($p = 0.004$, $p \approx 0.04$, and $p = 0.009$, respectively, Table 6).

The time occupied by patient care, administrative duties, lab work, and other duties for each MOS category can be seen in Figures 4a - 4d, with further task delineation in Figures 5a-5f. The task reported to most often result in pain was lip and cheek retraction (Figure 6), which is a task that each MOS category is required to perform).

A larger number of DAEF's and SA_HYG's reported having arthritis than did dentists ($p < 0.08$) and a greater number of dental assistants reported arthritis than dentists ($p < 0.05$, Table 6). DAEF's and SA_HYG's were 2.9 times more likely to have arthritis than were dentists. More DAEF's and SA_HYG's have arthritis than do dental assistants (the difference in the p value is due to using a Fishers Exact Test for Chi^2's with small numbers in each cell).

Upper Extremity Symptoms

Approximately seventy six percent of the dental workers surveyed reported one or more symptoms (75.6%). Although there were only five diagnosed cases of carpal tunnel syndrome (11%), it is important to note that individuals reporting five or more symptoms were more likely to report diagnosed CTS (Table 7). Individuals who had diagnosed CTS reported experiencing five or more symptoms more often (100%) than those without diagnosed CTS (30.8%) ($p < 0.006$). Individuals with diagnosed CTS were 3.3 times more likely to experience five or more symptoms than those without diagnosed CTS.

Hand/wrist symptoms of tingling, frequent dropping of objects, the sensation of "falling asleep", decreased sensation, and loss of strength are more likely to also have diagnosed CTS (Figure 7, Table 8). Twenty-five percent of the dental workers who reported the sensation of tingling in their fingers/hands also had CTS, while none of the dental workers who did not report numbness or tingling had diagnosed CTS ($p = 0.01$, Table 8).

More of the individuals who reported that they frequently drop objects (28.6%) reported having diagnosed CTS, than those that did not report CTS (3.3%) ($p < 0.3$, Table 8). Individuals who frequently drop objects were 8.57 times more likely to have CTS than those who do not frequently drop objects.

Approximately twenty-nine percent of the dental workers who reported the sensation of their fingers/hands "falling asleep" also had CTS (29.4%), while none of the dental workers who did not report this sensation had CTS ($p < 0.006$, Table 8). Nearly thirty-six percent of the workers reporting decreased sensation in their fingers and/or hands also had CTS (36.7%) while those without diminished sensation did not report CTS ($p = 0.002$, Table 8. Nearly twenty-four percent of the workers reporting loss of hand/wrist strength also had CTS (23.8%), while those not reporting loss of strength, did not have CTS (0.0%) ($p = 0.02$, Table 8). In this study, pain at night, stiffness, and swelling were not found to be significantly associated with diagnosed carpal tunnel syndrome.

Control Over Daily Work Routine

Individuals who felt they had little or no control over their daily work routine (64.7%) were more likely to experience five or more symptoms commensurate with an upper extremity repetitive trauma injury than those who felt they had moderate to total control (26.9%) ($p = 0.01$, Table 9). Approximately 65% of those individuals who reported they had little or no control also experienced five or more symptoms, while 26.9% of those reporting moderate to total control experienced five or more symptoms ($p = 0.014$, Table 9). Workers who felt they had less control over their schedules were 2.1 times as likely to experience a greater number of symptoms.

Those who felt they had little or no control were also more likely to believe that the sick leave they took in the last year was related to their work (52.9%) than those who felt they had more control (25%) ($p = 0.03$, Table 9). Individuals who think they have less control over their work routine were twice as likely to feel their sick leave was related to their work. It is not true that those people who were less satisfied with their job had more symptoms. In fact, although marginally significant, the opposite was true. Those individuals

who found their work satisfying or very satisfying reported more symptoms (43.6%) than those who found their work unsatisfying or very unsatisfying (0%) ($p = 0.06$, Table 10).

Sick Leave

Individuals experiencing 5 or more symptoms were nearly twice as likely to take sick leave than those experiencing 4 or less symptoms, however, this difference was not statistically significant (Table 11). Of all those that took sick leave in the last year, 46.9% believed the leave was related to their work duties ($p = 0.002$, Table 11).

More individuals who believe their previous years sick leave was related to their work also reported experiencing five or more symptoms (71%), than those who did not believe their sick leave was related to their work (23%) ($p = 0.002$, Table 12). Individuals relating their sick leave to their work were also more likely to have diagnosed CTS (Table 12). Approximately 27% of workers who believe their sick leave was related to their work duties had diagnosed CTS, while only 3.2% of those who did not believe their sick leave was related to their work ($p = 0.03$, Table 12) had CTS.

Work Schedule

Dental workers who treat 7-9 patients per day (56.3%) reported experiencing five or more symptoms more often than workers who treated either less or more symptoms (Table 13). Those treating 7-9 patients per day reported five or more symptoms significantly more often than those treating 6 or less patients ($p = 0.05$, Table 13).

Medical Treatment

The treatments sought by individuals who experienced hand/wrist symptoms are included in Table 14. Twenty percent reported using non-prescription treatments, 61% sought additional information from magazines or journals, and 38% reported consulting a health care professional. The health

care practitioners consulted most often were general medicine physicians, orthopedic surgeons, and occupational therapists (Table 15). Forty-four percent of the individuals that consulted a health care professional (n = 18) sought more than one professional opinion and 17% found the second opinion to be different from the first (Table 16).

The diagnosis suggested most often by health care practitioners was carpal tunnel syndrome (67%), while other diagnoses/terminology used included repetitive motion disorder (38%), repetitive motion trauma (38%), and repetitive strain (33%) (Table 17). Diagnostic studies suggested/used most often were nerve conduction studies (61%), X-rays (38%), grip and/or pinch strength testing (38%), and dexterity testing (33%) (Table 18). Treatments used most often were injection of corticosteroids, splinting, and exercise (Table 19). Although the number of respondents was small, splinting and exercise were considered to be the most effective and were effective more often than corticosteroid injections (Table 19). Eight respondents (18%) reported that they were currently receiving treatment (not included in tables). Self treatments to alleviate symptoms used most often were rest, over-the-counter medications, massage, tool adaptation, and shaking the hands (Table 20).

Prior History of Cumulative Trauma Disorder

A prior history of experiencing a cumulative trauma disorder was reported more frequently among DAEFs (62.5%) than other MOS categories (25% or less, Table 21). DAEFs were 8.8 times more likely to report a prior history of CTD than were dentists ($p = 0.01$). Persons with a prior history of CTD were also more likely to report 5 or more hand/wrist symptoms, and hand/wrist symptoms of tingling/numbness, pain at night, the sensation of "falling asleep" during normal activities, loss of strength, decreased sensation, frequent dropping of objects, and swelling (Table 22). Only stiffness was not associated with a history of CTD (Table 22). Those with a history of CTD were 12 times more likely to also report experiencing carpal tunnel syndrome than those with no history of CTD, although the confidence interval was quite large ($p = 0.01$, Table 22). They were also six times more likely to report using non-prescribed treatments than those not reporting a history of CTD ($p = 0.004$,

Table 22).

Back and Shoulder Pain

Back and shoulder pain was reported by 53% of the respondents. As mentioned previously, more women reported back pain than men (Table 3) and persons weighing less than or equal to 150 lbs reported back pain more frequently than those weighing over 150 lbs (Table 4).

INTERVIEWS

Interviews revealed 11 important concerns, which we grouped into three major categories of building concerns, equipment concerns, and administrative concerns. Building concerns included low building temperatures, excessive noise, and physical ailments similar to those experienced in "sick building syndrome". Equipment concerns included hand-held instruments connected to heavy, resistive hoses, overly tight vacuum control knobs, the need for right-handed dental assistant chairs, lack of back and arm support on chairs, and instruments needing to be properly sharpened. Administrative concerns included being overworked and understaffed, an emphasis on maximizing the number of patients treated, and a lack of task variety.

DISCUSSION

Earlier studies have evaluated the prevalence of CTS and associated symptoms in large populations of dental hygienists (Macdonald, 1988; Osborn, 1990). This study evaluated dental assistants, dental hygienists, dental assistants-expanded-function, and dentists. This study also involved a closer look at work conditions that might effect the prevalence of CTD.

A greater number of subjects reported one or more hand/wrist symptoms, CTS, and back/shoulder pain in this worksite analysis than in prior

surveys of dental hygienists (Table 23). This occurred for each MOS category (Table 21). Although this could be due to the presence of the researchers and the interviews, it was noted by the research team that our presence and interviews seemed to result in our helping respondents to distinguish symptoms commensurate with CTD versus transient symptoms. That is, fewer symptoms were claimed as a result. Two important factors should be noted, however. First, the dental clinic requested assistance to identify whether a problem existed, indicating an already present concern. Second, the number of respondents in our analysis was substantially less than that of previous research, collected in the form of mass mailing surveys.

In the general population, CTS occurs more often in women than in men and seems to be more prevalent between the ages of 40 and 60. However, none of the demographic data in this study were found to be associated with hand/wrist symptoms, CTS, back or shoulder pain. In contrast, Macdonald, et al. (1988) found correlations among age and hand weakness, hand clumsiness, and CTS.

Similar to findings by Macdonald et al. (1988), no relationships were found among leisure activities and finger/hand symptoms, CTS, back or shoulder pain. In addition, no relationship was found between subjective assessment of general health and CTD symptoms.

Unlike Macdonald, et al. (1988), we did not find that specific hand/wrist symptoms, the number of symptoms, or the presence of CTS were related to number of years in practice or the number of hours practiced per week. Although we did find that the number of patients treated per day was related to the number of symptoms, dental workers who treated 7 - 9 patients per day reported more symptoms than workers treating a higher number of patients. The difficulty of the work was not considered in this study. However, Macdonald (1988) found the number of patients with heavy calculus on their teeth (treated per day) was associated with the presence of symptoms. Our unexpected finding associating 7 - 9 patients with the number of symptoms may be indicative of the types of patients which are seen.

A comparison of symptoms found in this study with that of Macdonald and Huntley is listed in Table 24. We measured several symptoms not evaluated in Macdonald's study (sensation of "falling asleep" during normal

activity, stiffness, and swelling). Our findings agree with Osborn's (1990) findings that tingling/numbness, clumsiness (dropping), and loss of strength were associated with CTS (Table 25). However, we did not find that night pain was associated with CTS and we additionally found that sensations of the fingers/hand "falling asleep" and decreased sensation were associated with CTS (Table 25).

Thirty eight percent of those filling out the questionnaire sought medical treatment and 40% of the individuals with diagnosed CTS had undergone surgery. Obviously, not all individuals that experienced symptoms sought medical care. Some individuals may have experienced transient symptoms as a result of a temporary condition, such as a "breaking in period" or pregnancy. Others may have chosen to treat themselves or alter their work conditions. During interviews, some individuals reported that they had changed specialty areas within the dental professions (such as becoming a specialty assistant after working as a dental hygienist), altered their work style (alternating hand use), or had even left the practice of dental work for a period of time.

The task reported most frequently to cause pain was retraction. This static task is required of each of the dental MOS categories. In the videotape analysis, "holding" (ie. retraction) was found most often in the work of the dental hygienists and the DAEFs. The other task element occurring more often during the videotape analysis for DAEF's was the high percentage of time spent with the right hand in flexion. Smith et al. (1977) indicated that maximal pressure on the median nerve is related to the load on the flexor digitorum profundus tendons of the second and third digits (as occurs in pinch) and that greater pressure occurs when the wrist is flexed. DAEF's and dental hygienists also reported spending more time scaling and polishing than did the other MOS's evaluated.

The greatest risk factors may be the type of patients seen, the tasks which dominate dental practitioners daily routine, using the hand in a flexed position, and the practitioners methods of practice. Methods of practice refers to the dynamic motion (velocity and acceleration) and force used during work, as both have been indicated in previous research to be associated with high risk jobs for CTS (Marras and Schoenmarklin, 1991). Cuthbertson et al.(1988) found dental hygienists with CTS symptoms used a mean scaling pressure that

was 66% higher than those without symptoms. The same relationship did not hold true for total pressure differences between those with and without CTS symptoms. Unfortunately, these results cannot be used to indicate that force was necessarily a causal factor in symptom development, as increased force may have been used to compensate for symptoms of paresthesia. The findings may also indicate specific tasks (e.g. scaling) are more closely associated with the risk for development of CTD symptoms, which has been surmised by other authors (Bauer, 1985; Edgington, 1983)

Although we did not evaluate frequencies of predisposing factors, we did evaluate physician's assessments of possible causes of the symptoms (Table 17). Our findings agreed with Osborn's (1990) finding that rheumatoid arthritis was mentioned as one of the leading associated factors. Osborn (1990) found splinting was the treatment used most often, followed by non-steroidal anti-inflammatory drugs, surgical release, and steroid injections, while we found steroid injections, splinting, and exercise to be the most frequent treatments (Table 19). In the findings on subjective reports of treatment success, our study revealed splinting to be considered 100% successful, while only 50% of those in Osborns (1990) study found it successful. Our findings of 56% considering corticosteroid injection as successful is considerably higher than that of Osborne (1990) at 18%.

Medical symptoms which can contribute to the risk for development of CTS include diabetes mellitus, hyperthyroidism, pregnancy, arthritis, myxedema, and injuries to the wrist. Osborn (1990) found that arthritis and traumatic injury to the wrist appeared to put respondents at greater risk for development of symptoms. Although the incidence of arthritis was greater among DAEFs and SA_HYG MOS groups, arthritis was not found to be associated with the number of hand/wrist symptoms, prevalence of CTS, or back pain. Traumatic injury was also not associated with hand/wrist symptoms.

Feelings of control over one's daily work routine were associated with the number of hand/wrist symptoms and with the belief that sick leave taken was related to work requirements. These findings could reflect scheduling of tasks which are ergonomically demanding one after another by administrative staff, who may not comprehend the difficulties involved. It is important to note that these are not individuals who are merely dissatisfied with their work. These are

individuals who appear to enjoy their profession and the general work environment; but are having hand/wrist symptoms and are concerned about their health, their ability to do their job, and their future.

Obviously, the presence of upper extremity symptoms in the workforce is affecting the workforce, as those experiencing 5 or more symptoms were nearly twice as likely to take sick leave as those experiencing fewer symptoms. We did not compare number of workdays lost for individuals with and without CTS. However, among aircraft workers, those with CTS are reported to miss 54.3 workdays compared with 9.8 workdays lost by those without CTS (Cannon, Bernacki, and Walter, 1981). In addition, a large percentage of those who took sick leave in the last year believed the leave was related to their work duties. Associated costs of worker injuries include the frustration and lack of faith in the administration that can result, as well as the lost duty time. A proactive program (such as that being sought and developed at Ft. Leonord Wood) to address legitimate, work related health concerns can prevent workers from becoming discouraged and disillusioned.

CONCLUSIONS

Definite implications for dental practitioners are evident from the results of this study. Although DAEFs were found to be at greatest risk for development of upper extremity symptoms and carpal tunnel syndrome, each of the MOS groupings displayed a high percentage of hand/wrist symptoms. In addition, back pain was noted with alarming frequency. Prevention, followed by early identification and treatment are the preferred methods of managing cumulative trauma disorders. Applying sound ergonomic design principles in the workplace can best guide an injury prevention program by emphasizing workplace re-design, use of ergonomically designed instruments and furniture, training and education, environmental changes, administrative solutions, and establishment of a medical surveillance program.

Although factors known to be associated with the development of carpal tunnel syndrome have been identified, the exact causes are still being

investigated. From the results of this study, it appears that static, awkward positions of the wrist (flexion) and fingers (pinch), and repetitive wrist motions are implicated. Specific tasks may emphasize these motions resulting in localized fatigue, putting the practitioner at greater risk. Prospective studies investigating dynamic motion and force are necessary to more accurately define work related causes and develop effective preventive programs.

RECOMMENDATIONS

Based on this worksite evaluation, we provide the following recommendations for the Ft. Leonord Wood Dental Service:

EQUIPMENT

A. Chairs - suggest purchase of new chairs:
   1. an ergonomic design is needed: (1) dental assistant chairs: need back support as well as support for trunk (forward lean) and arms (2) a second design for dentists, possibly with a higher back, removable arm rests that also rotate and can be adjusted for length.
   2. adjustability of seat pan, seat back, arm-rests, trunk support, lumbar support, and seat height should be emphasized.
   3. Right handed assistant chairs are needed. Many of the current chairs are designed for left handed assistants, often resulting in assistants using their knees or legs to brace themselves. This increases static strain on their trunk, shoulder and back muscles.

- Potential sources: Although the dental clinic undoubtedly has access to numerous sources, two were mentioned specifically by dental personnel at the

clinic investigated and at other clinics: ErgoDental Seating (Unitek), BodyGuard Seating Systems.

B. Instruments

1. Need for an air and water syringe which does not require as much pressure to use as the present model. Update older water and air syringes which require substantial thumb pressure to operate. Speak with suppliers about difficulties with buttons on equipment which require considerable effort, often they can be replaced fairly inexpensively.
2. Need for hand pieces (instruments) which are lighter and for the cables to exert less resistance, thus decreasing pressure on the web space of the hand. Handle length may increase instrument weight and be unnecessary for the task.
3. Larger diameter handles may be helpful (if the instrument and the procedure permit). (As many instruments require a pinch grip, this may be all that is available, however, voicing concerns to suppliers may result in their hiring human factors engineers/ergonomists to redesign dental tools to prevent injuries.)
4. Use a combination of automated and traditional techniques to decrease the repetitive, forceful, awkward use of hands.
5. Use mirrors as much as possible to reduce abnormal postures.
6. Suggest using instruments with handles which permit the wrist to be held in neutral as much as possible, are non-metal to eliminate effects of cold conductivity, and changing types of instruments (or to instruments with different handles) to permit different gripping methods throughout the day.
7. Use of a 360° swivel handpiece, fiberoptics, and an over-the-patient delivery system were suggested by a dentist

who had personally experience CTS (Schlim, 1990).

8. Gloves should fit properly, that is, they should conform to the hand (without being too tight) and move easily, without restricting movement.

ADMINISTRATION

A. Scheduling: Stagger work schedules to reduce the work/rest ratio for particular body parts as much as possible.

1. Similar tasks should not be scheduled together to allow muscles to recover, especially tasks requiring high repetitiveness, awkward/extreme positioning, high pinch force, and long periods of time in static posture (such as scaling).
2. Alter tasks on the same patient to prevent overuse of one muscle group. For example, if patient has heavy calculus,then intersperse cleaning/scaling with checking of other areas.
3. Consider methodology for dental workers to have some control in patient scheduling.
4. Alternate scheduling for easy and hard patients/procedures.
5. Similarly, there should be a mixture of types of patients.
6. Rest hands/wrists between patients, do gentle stretching of fingers, wrists, arms, shoulders, neck, and back. (Occupational or Physical Therapy Dept's may be able to provide exercises.)
7. Schedule regular rest breaks.
8. If necessary, schedule multiple visits per patient, rather than trying to finish everything in one visit.
9. Job rotations should be used to permit longer periods of recovery time.
10. Pro-active scheduling to decrease work/rest ratio's for the

hand and wrist, forearm and shoulder, neck, and back is very important. Waiting until symptoms appear or a clinical diagnosis is made will prolong the recovery period and possibly result in long term disability.

B. Continuing education/reinforcement of skills

1. Need for proper patient-operator positioning.
2. Appropriate instruments need to be maintained (sharpened), replaced, and properly placed.
3. Reinforce appropriate techniques for technicians.
4. Emphasize use of ergonomic principles during work.
5. When staggering tasks, recognize similar motions of different jobs (pinch in writing may be similar to pinch used during patient care).
6. Provide continuing education on "four-handed" dentistry or other pertinent techniques.
7. Include training as part of the introduction of any new equipment in the dental clinic, to include items such as adjustable ergonomic chairs, the cavitron, etc.
8. Provide continuing education on occupational injuries for dental workers, to include: ergonomic, individual, and medical risk factors that may be related to cumulative trauma injuries. Filming short segments of the individuals work and letting them critique the worksite and/or their own postures is an excellent tool.
9. Periodic stress management classes/seminars. High stress can result in increased fatigue and fatigue may develop more quickly during stress. In addition, instruments may be gripped more tightly during times of high stress or fatigue.

C. Medical Surveillance

1. A medical surveillance mechanism is recommended.

2. This may be internal to the Dental Clinic, as well as part of an over all occupational safety and health program.
3. An ergonomics committee may be created, which reflects the composition of the Occupational Safety and Health Council and is subordinate to that council. This committee can oversee the surveillance mechanism, which can be developed at Ft. Leonord Wood, perhaps with the assistance from Occupational and/or Physical Therapy Personnel.
2. Suggested components of the surveillance mechanism (as recommended in the OSHA draft "Ergonomics Program Management Recommendations for General Industry"):
   a. Baseline collection of symptoms and medical concerns upon initial assignment.
   b. Re-recording of symptoms post-conditioning phase of assignment (perhaps one month later).
   c. Periodically thereafter.
3. Two suggested formats are diagrams of human figures, in which the worker shades areas where symptoms are occurring and checklists.
4. Workers should judge their own symptoms and seek medical care when they feel it is necessary, depending on the frequency, duration, and severity of the symptoms. Some guidelines are; if the symptoms wake the individual at night, symptoms persist after leaving work for several hours, and if symptoms are present on a daily basis, then medical consultation may be indicated. Guidelines may be developed by the local ergonomics committee.

D. Community Education
   1. Encourage preventive care for military personnel to reduce high levels of periodontal disease (short articles in post or hospital bulletin).

ERGONOMIC PRINCIPLES

A. Avoid extremely tight gripping, as blood flow to the muscles used becomes restricted. For example, when scaling, use of a loose grip until hitting calculus, then tighten grip as necessary.

B. Avoid rushing, as the speed of repetitive motions has been shown to be associated with cumulative trauma injury.

C. Try to avoid static postures, highly repetitive movements, and the use of the same muscles for different tasks.

D. Change body and hand positions often.

E. Some workers may be able to become somewhat adept at using both hands for difficult tasks, to enable switching hands during a procedure.

F. Increased communication and concern for one another can build cohesion. It has been shown that good communication can reduce stress (which effects fatigue and muscular tension).

G. Learn to accept the idea of injury prevention, reschedule patients if stiffness and muscle fatigue occurs.

H. Workplace layout and worker positioning should permit the head and trunk to be held upright or for the head to be inclined slightly forward. Use of mirrors, moving the patient, or moving the patients head slightly may help to achieve such a position much of the time.

I. Several different, but equally safe, useful postures should be identified and used during dental work.

J. Joints should be used at approximately the midpoint of their range of motion. This applies especially to the head, neck, and upper extremity. For the wrist, this is the neutral position. Avoid extreme wrist flexion, extension, ulnar and radial deviation.

K. When using extreme muscle force, use the largest muscle group that is appropriate. For example, use a power grip rather than a pinch grip, if possible.

L. Although this study did not find vibration to be a problem, be aware that it can also interfere with circulation. Move, stretch, or "shake-out" your hands and fingers after use of vibratory tools.

ENVIRONMENTAL

1. Proper temperatures to prevent finger and hand stiffness is important both for prevention of cumulative trauma and patient care.

RESEARCH

1. Prospective studies investigating dynamic motion and force are necessary to define work related causes and develop effective preventive programs.
2. Clinical studies which identify the progression of CTS symptoms and success rates of various treatment regimens are also suggested.

TRAINING

1. Inclusion of information on ergonomics hazards during training of dental assistants and DAEF's at the Academy of Health Sciences.

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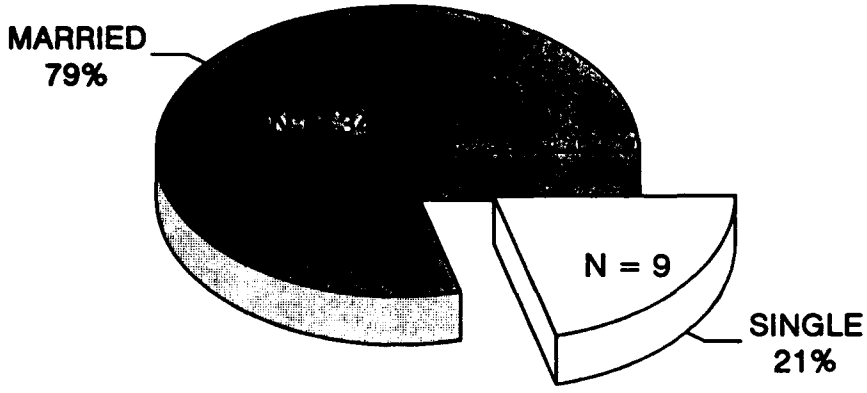

Figure 1a. Marital status of respondent population.

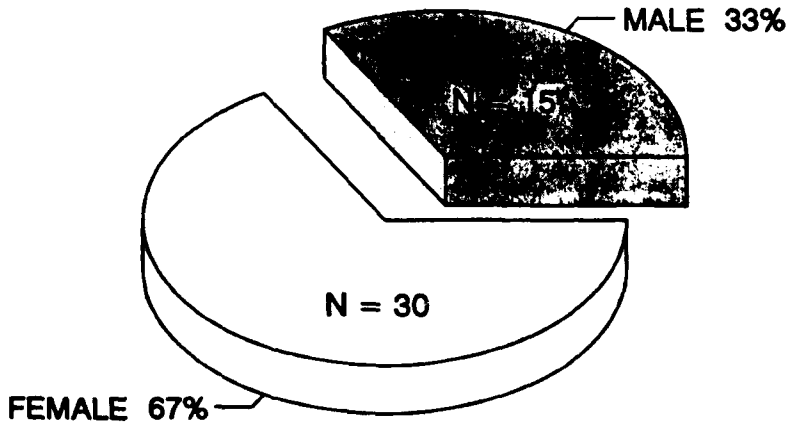

Figure 1b. Gender distribution of respondent population.

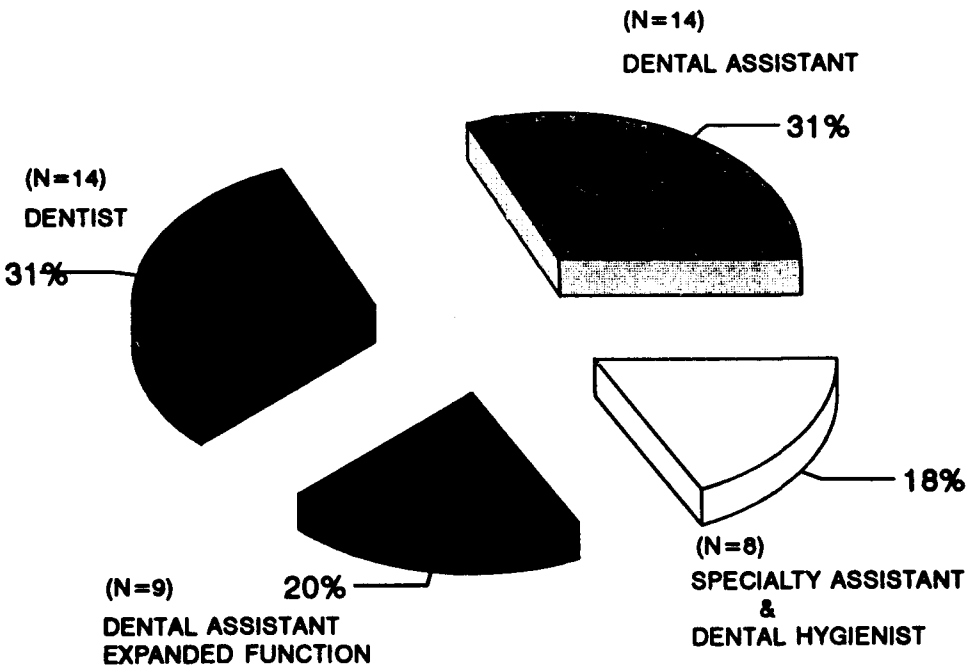

Figure 1c. MOS distribution of respondent population.

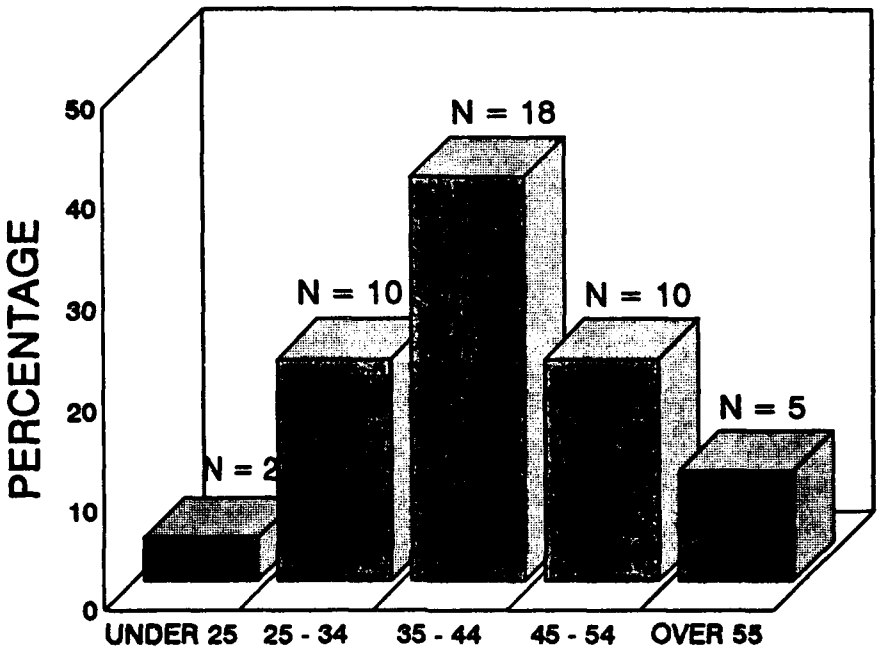

Figure 2a. Age distribution of respondent population.

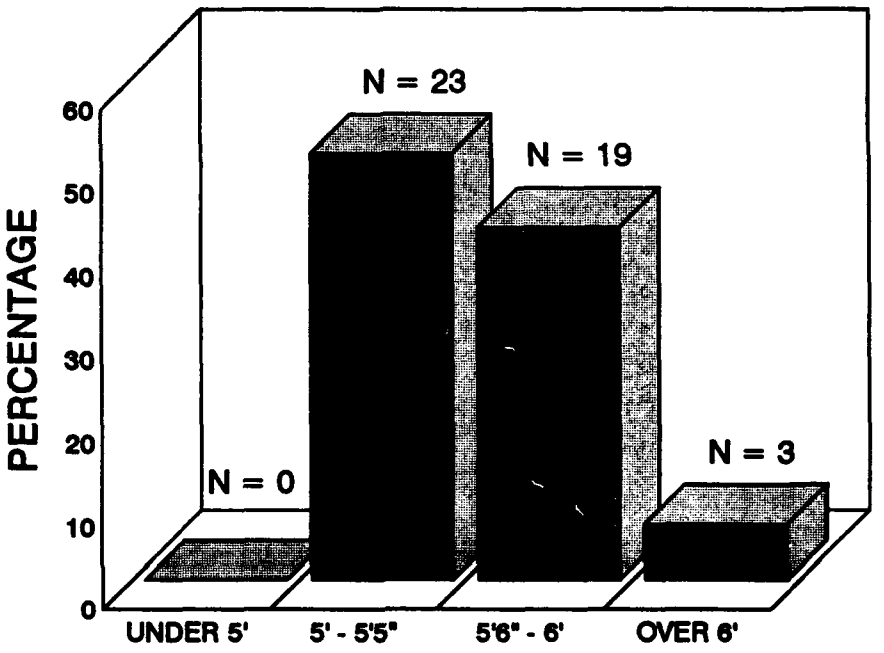

Figure 2b. Height distribution of respondent population.

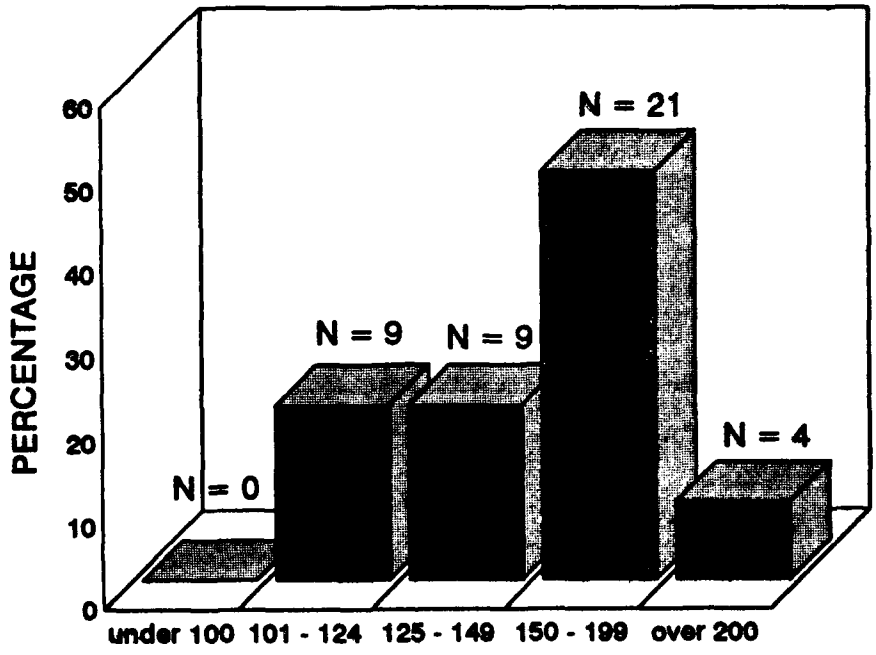

Figure 2c. Weight distribution of respondent population.

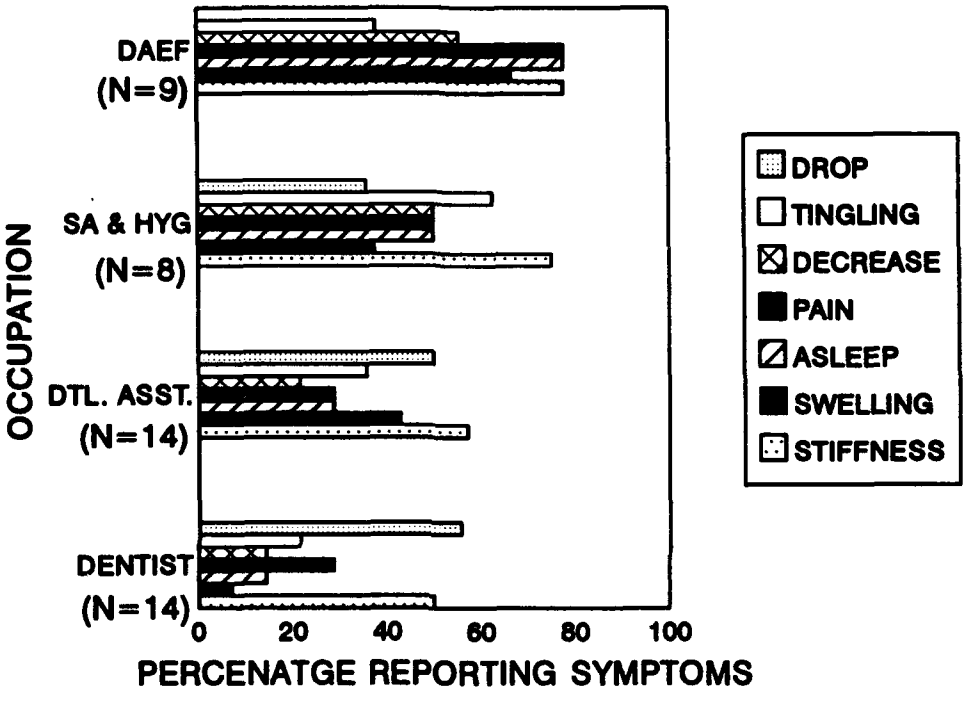

Figure 3. Frequency distribution of CTS symptoms by MOS.

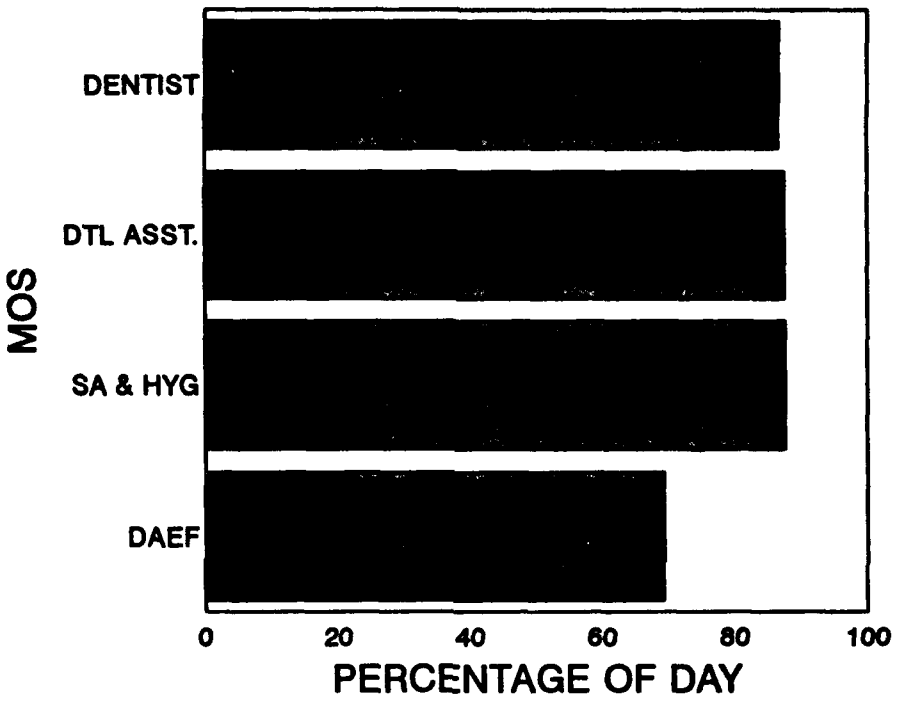

Figure 4a. Time occupied by patient care.

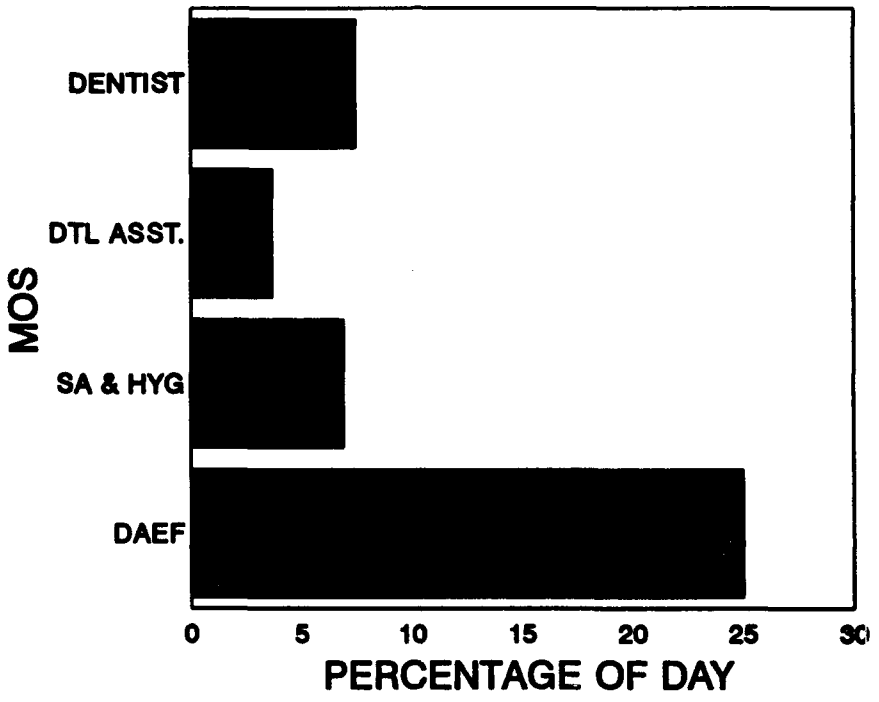

Figure 4b. Time occupied by administration duty.

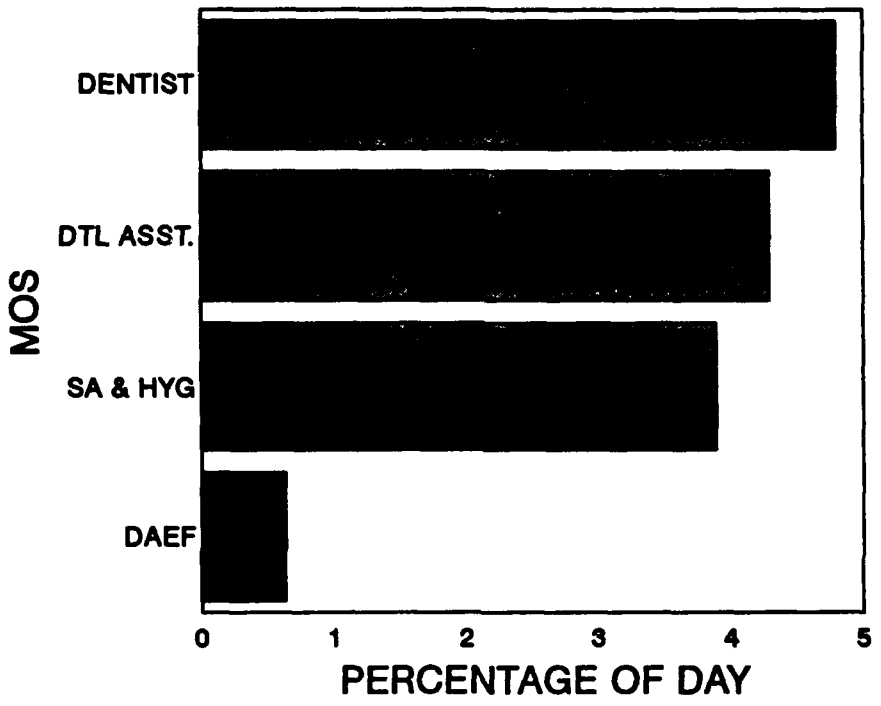

Figure 4c. Time occupied by laboratory work.

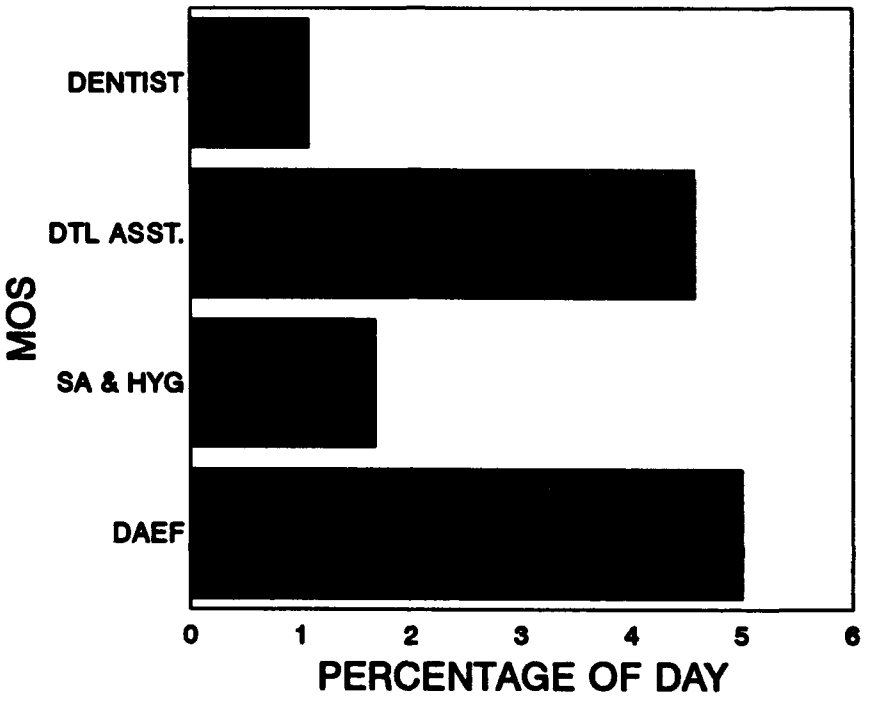

Figure 4d. Time occupied by other activity.

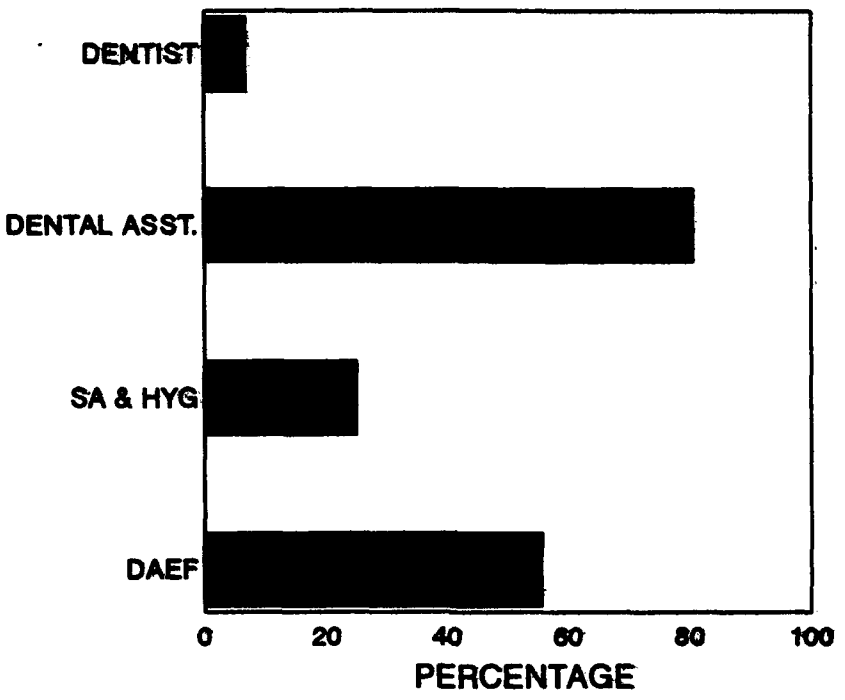

Figure 5a. MOS vs. mixing.

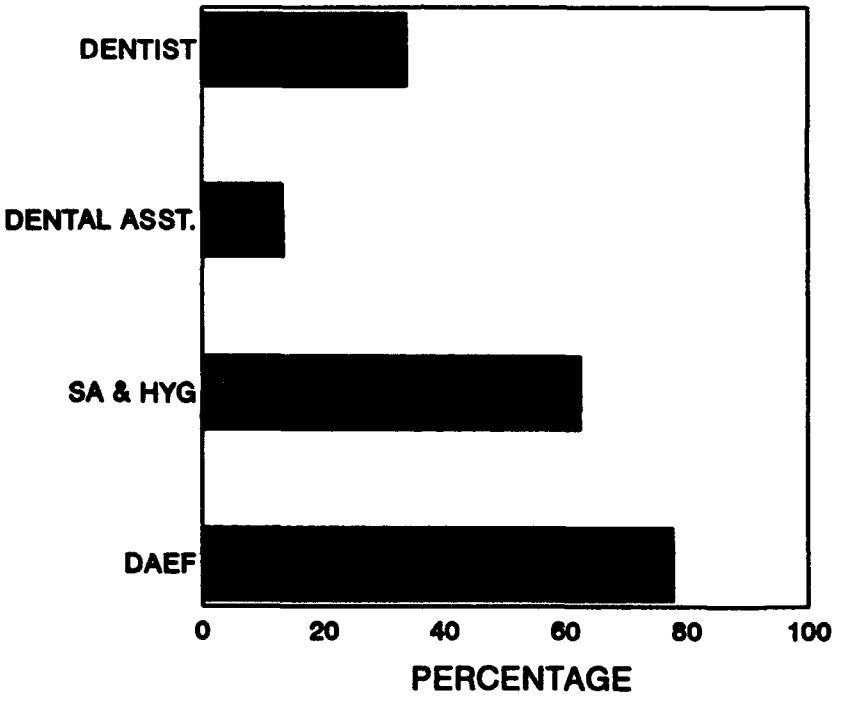

Figure 5b. MOS vs. polishing.

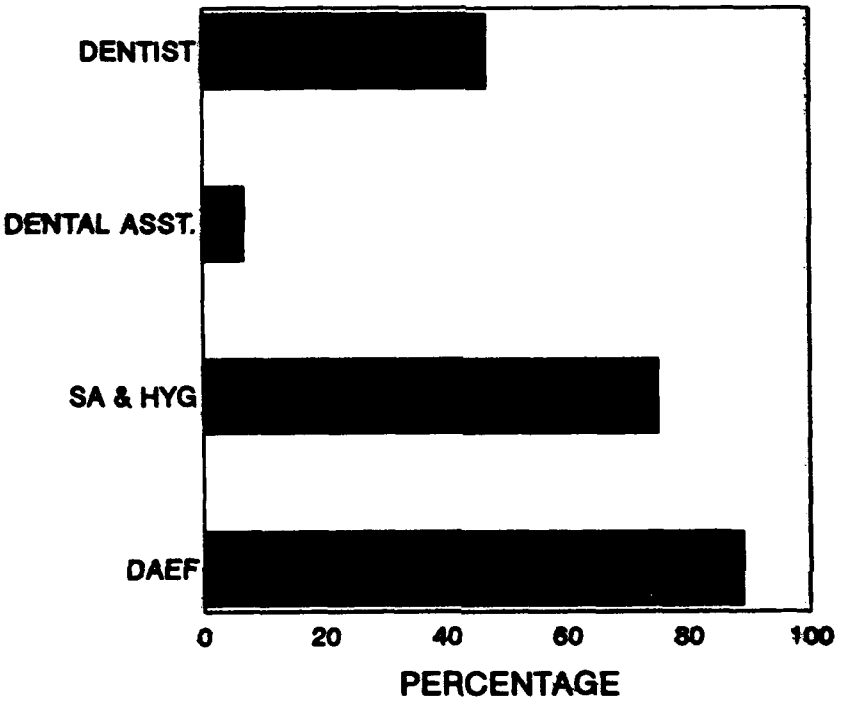

Figure 5c. MOS vs. scaling.

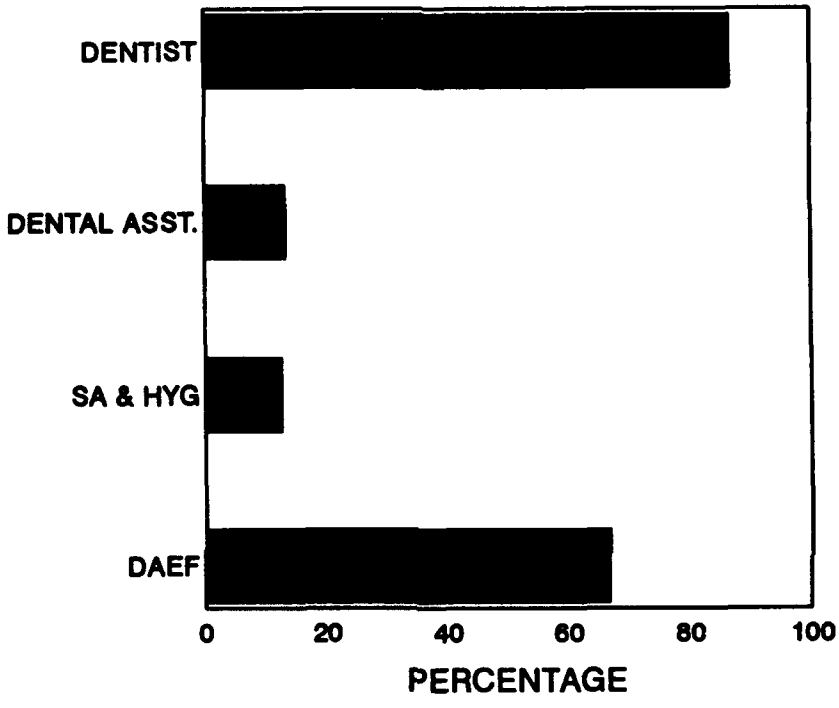

Figure 5d. MOS vs. filling.

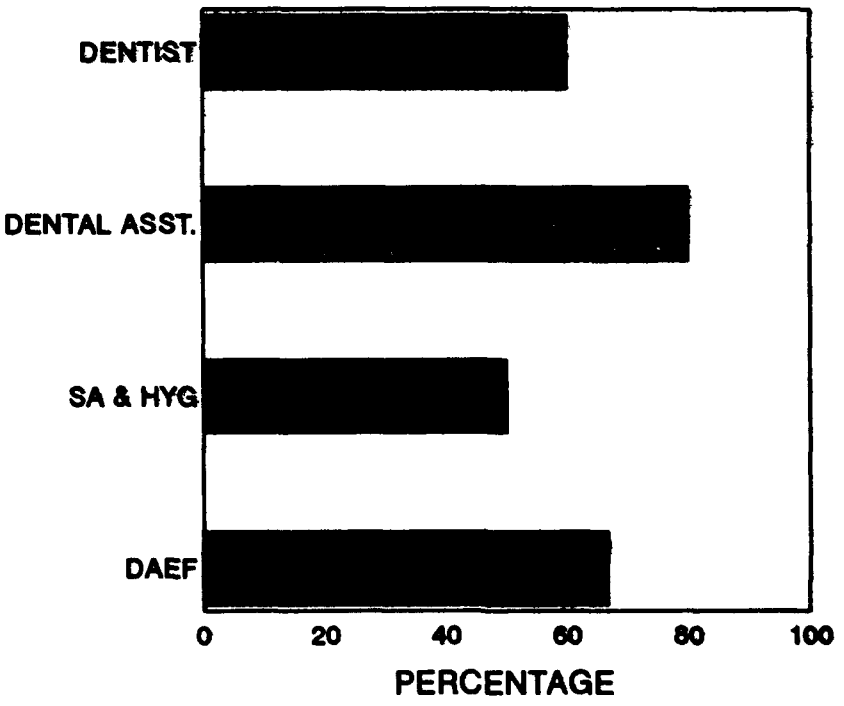

Figure 5e. MOS vs. impression making.

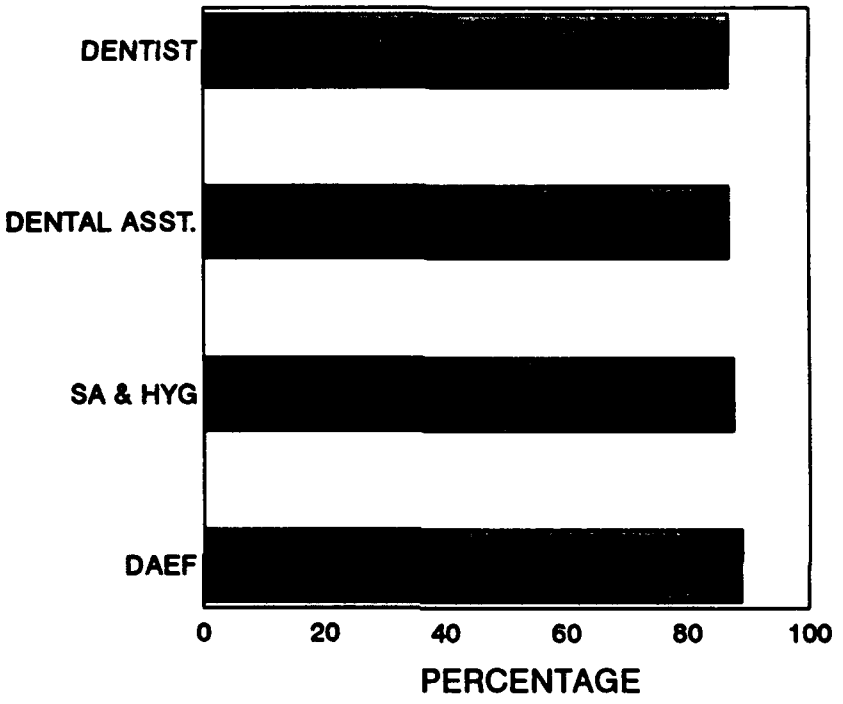

Figure 5f. MOS vs. lip and cheek retraction

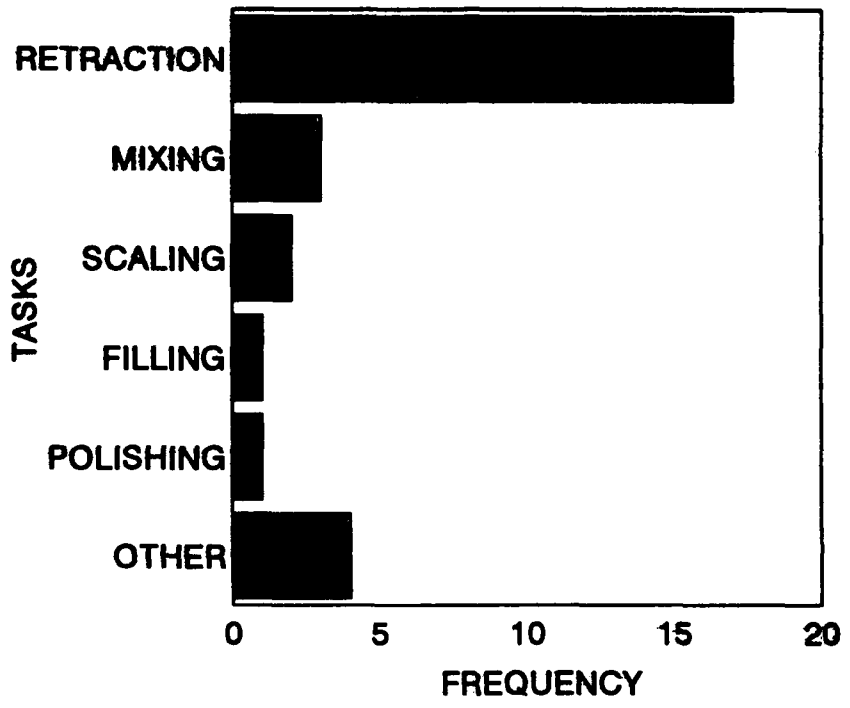

Figure 6. Tasks reported most frequently to cause pain.

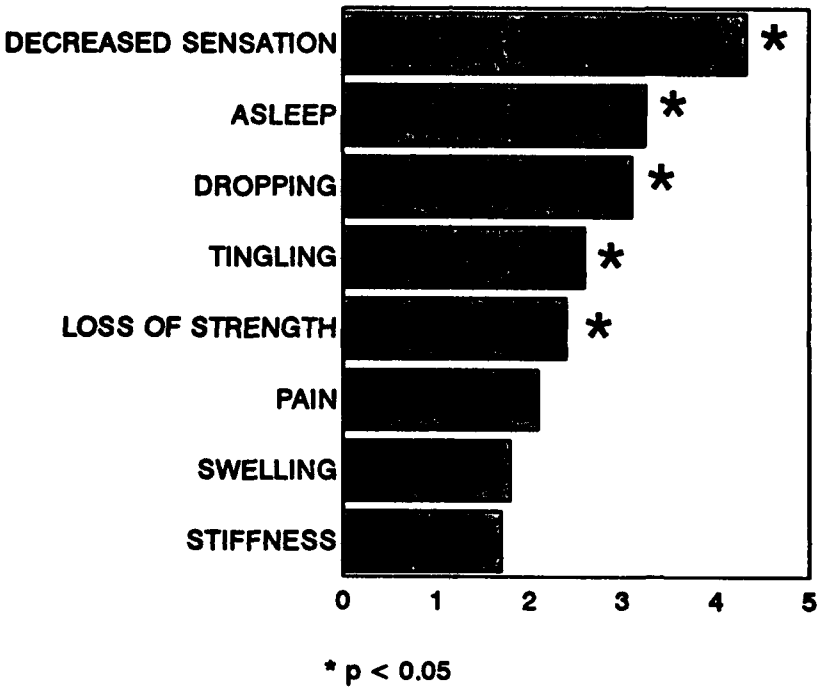

Figure 7. Risk ratios for CTS.

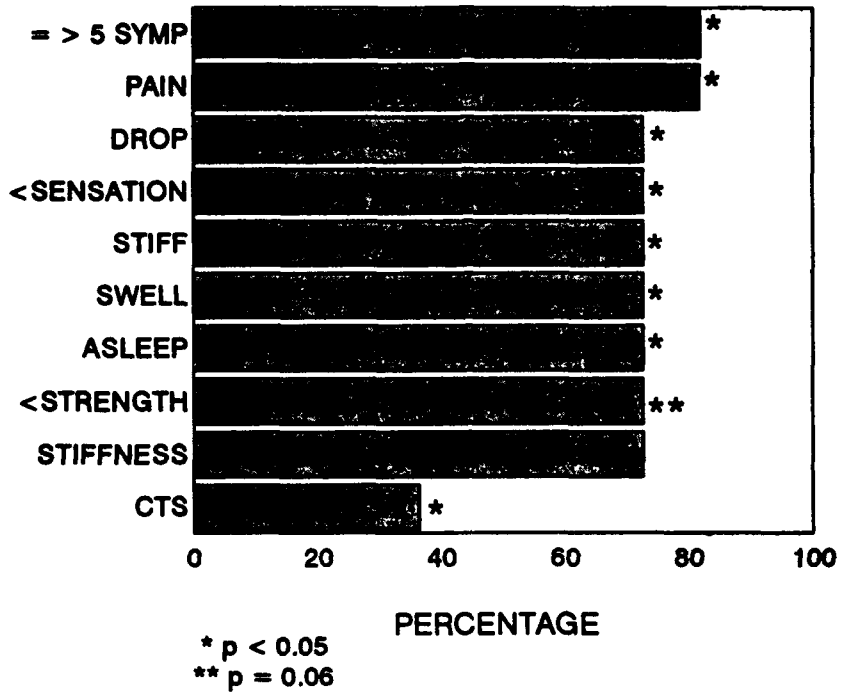

Figure 8. Frequency of symptoms among people with a history of cumulative trauma.

Table 1. Videotape Work/Rest Cycles for Tasks

DENTIST		DENTAL HYGIENIST		DAEF	
Left	Right	Left	Right	Left	Right
2.75/1	5.31/1	6.50/1	6.19/1	4.44/1	2.60/1

Table 2. Percent of Time in Static Hand/Wrist Postures.

	DENTIST		DENTAL HYGIENIST		DAEF	
hand/wrist position	left	right	left	right	left	right
power	0.0	5.6	1.2	7.0	3.2	12.3
pinch	59.2	69.5	53.0	79.1	50.2	66.5
hold	14.8	9.7	32.5	0.0	29.2	< 1.0
other	26.9	16.0	13.3	13.9	17.6	21.8
ulnar	1.7	33.4	32.6	26.8	17.1	8.8
radial	< 1.0	2.0	< 1.0	0.0	0.0	0.0
neutral	< 1.0	5.0	< 1.0	2.4	2.9	7.5
flexion	55.1	39.4	30.5	32.4	37.8	50.1
extension	15.4	2.0	21.8	17.2	19.5	12.4
other	28.2	23.1	14.5	21.3	22.7	23.8

Table 3. The Relationship Between Gender and Back Pain.

	n	percent (%)	Risk Ratio	Confidence Interval	p value
MALE	15	33.3			
FEMALE	29	65.5	1.97	0.92 < RR < 4.21	0.04

Table 4. The Relationship Between Weight and Back Pain.

	n	percent (%)	Risk Ratio	Confidence Interval	p value
> 150 lbs	25	40.0			
≤ 150 lbs	17	76.4	1.91	1.11 < RR < 3.31	0.02

Table 5. MOS X History of CTD and Number of Symptoms.

CONDITION	MOS	PERCENTAGE	RISK RATIO	CONFIDENCE INTERVAL	P VALUE
HISTORY OF CTD	DENTIST	07.1			
	DENTAL ASST.	21.4	3.00	0.43 < RR < 25.46	0.600
	SA_HYG	25.0	3.50	0.81 < RR < 32.80	0.530
	DAEF	62.5	8.80	1.23 < RR < 62.34	0.010
# OF SYMPTOMS ≥5	DENTIST	14.2			
	DENTAL ASST.	28.5	2.0	0.43 < RR < 9.21	0.650
	SA_HYG	50.0	3.5	0.81 < RR < 15.05	0.140
	DAEF	77.7	5.5	1.23 < RR < 20.58	0.007

Table 6. MOS X Reported Symptom or Condition.

CONDITION	MOS	PERCENTAGE	RISK RATIO	CONFIDENCE INTERVAL	P VALUE
SWELLING	DENTIST	07.1			
	SA_HYG	37.5	5.25	0.65 < RR < 42.44	0.120
	DENTAL ASST.	42.9	6.00	0.83 < RR < 43.65	0.060
	DAEF	66.7	9.33	1.34 < RR < 65.23	0.005
TINGLING	DENTIST	21.4			
	SA_HYG	35.7	1.7	0.49 < RR < 05.67	0.68
	DENTAL ASST.	62.7	2.9	0.93 < RR < 09.10	0.06
	DAEF	77.8	3.6	1.25 < RR < 10.50	0.01
DECREASED SENSATION	DENTIST	14.3			
	SA_HYG	21.4	1.5	0.29 < RR < 07.65	0.50
	DENTAL ASST.	50.0	3.5	0.81 < RR < 15.05	0.14
	DAEF	55.6	3.9	0.95 < RR < 15.93	0.05
PAIN AT NIGHT	DENTIST	28.6			
	SA_HYG	28.6			
	DENTAL ASST.	50.0	1.8	0.59 < RR < 05.15	0.39
	DAEF	77.8	2.7	1.11 < RR < 06.69	0.04
FALLING ASLEEP	DENTIST	14.3			
	DENTAL ASST.	28.6	2.0	0.43 < RR < 09.21	0.65
	SA_HYG	50.0	3.5	0.81 < RR < 15.05	0.14
	DAEF	77.8	5.4	1.44 < RR < 20.58	0.006
DROPPING	DENTIST	00.0			
	SA_HYG	35.7			0.04
	DENTAL ASST.	50.0			0.009
	DAEF	55.6			0.004
ARTHRITIS	DENTIST	21.4			
	DENTAL ASST.	57.1	2.7	0.89 < RR < 8.02	0.05
	SA_HYG	62.5	2.9	0.93 < RR < 9.10	0.06
	DAEF	62.5	2.9	0.93 < RR < 9.10	0.06

Table 7. CTS X Number of Symptoms (≥5 symptoms).

CONDITION	CTS	PERCENTAGE	RISK RATIO	CONFIDENCE INTERVAL	P VALUE
≥5 Symptoms	NO (n = 12) YES (n = 5)	30.8 100.0	3.3	2.03 < RR < 5.20	0.006

Table 8. CTS x Symptoms of the Fingers/Hand/Wrist.

CONDITION	CTS	PERCENTAGE	RISK RATIO	CONFIDENCE INTERVAL	P VALUE
TINGLING	NO (n = 20) YES (n = 24)	00.00 25.00			0.01
FREQUENT DROPPING	NO (n = 14) YES (n = 30)	03.30 28.60	8.57	1.05 < RR < 69.82	0.03
FALLING ASLEEP	NO (n = 17) YES (n = 27)	00.00 29.40			0.03
DECREASED SENSATION	NO (n = 14) YES (n = 30)	00.00 35.70			0.02
LOSS OF STRENGTH	NO (n = 21) YES (n = 23)	00.00 23.80			0.02

Table 9. Job Control X Number of Symptoms (≥5) and Belief that Last Year's Sick Leave was Related to Work.

CONDITION	CTS	PERCENTAGE	RISK RATIO	CONFIDENCE INTERVAL	P VALUE
NUMBER OF SYMPTOMS (≥5)	MOD/TOTAL CONTROL (n = 17) NO/LITTLE CONTROL (n = 26)	26.9 64.7	2.4	1.17 < RR < 4.96	0.01
BELIEF LEAVE WAS RELATED TO WORK	MOD/TOTAL CONTROL (n = 17) NO/LITTLE CONTROL (n = 26)	25.0 52.9	2.1	1.03 < RR < 6.25	0.03

Table 10. Job satisfaction X Number of Symptoms (≥5).

CONDITION	SATISFACTION	PERCENTAGE	RISK RATIO	CONFIDENCE INTERVAL	P VALUE
NUMBER OF SYMPTOMS (≥5)	UNSATISFIED/VERY UNSATISFIED (n = 6) SATISFIED/VERY SATISFIED (n = 39)	00.0 43.6			0.06

Table 11. Sick Leave Taken in the Last Year X Number of Symptoms and Belief that Sick Leave was Related to Work.

CONDITION	SICK LEAVE	PERCENTAGE	RISK RATIO	CONFIDENCE INTERVAL	P VALUE
NUMBER OF SYMPTOMS (≥5)	NO (n = 13) YES (n = 31)	23.1 45.2	1.96	0.67 < RR < 5.68	0.17
BELIEF LEAVE RELATED TO WORK	NO (n = 14) YES (n = 32)	00.0 46.9			0.002

Table 12. Belief that Sick Leave was Related to Work X Number of Symptoms (≥5) and CTS.

CONDITION	SICK LEAVE	PERCENTAGE	RISK RATIO	CONFIDENCE INTERVAL	P VALUE
NUMBER OF SYMPTOMS (≥5)	NO (n = 14) YES (n = 30)	23.3 71.4	3.06	1.48 < RR < 6.34	0.002
CTS	NO (n = 15) YES (n = 31)	03.2 26.7	8.34	1.01 < RR < 67.77	0.03

Table 13. Number of Patients/Day x Number of Symptoms.

PATIENTS/ DAY	n	percent (%)	RR	Confidence Interval	p value
6 or less	5	0.0			
10 - 15	13	30.8			0.28
16 or more	11	36.4			0.25
7 - 9	16	56.3			0.04

Table 14. Treatments Sought by Individuals Experiencing Hand/Wrist Symptoms.

	n	YES	NO	No response
Non-prescription Tx.	18	20%	80%	
Magazines/Journals	18	61%	39%	
Consult Professional	47	38%	36%	26%
Receiving professional Tx.	18	18%	66%	

Table 15. Health Care Providers Consulted.

	percent	n
General Medical Physician	67%	12
Orthopedic Surgeon	67%	12
Occupational Therapist	50%	9
Chiropractor	28%	5
Physical Therapist	22%	4
Neurosurgeon	22%	4
Physician's Assistant	17%	3
Obstetrician/Gynecologist	11%	2
Internal Medicine Physician	6%	1
Nurse	6%	1
Rheumatologist	6%	1

Table 16. Percentage of Individuals Seeking More Than One Opinion (n=18).

	Yes	No
Sought more than one opinion:	44%	56%
Second opinion different:	17%	83%

Table 17. Conditions Suggested by Health Care Providers as the Cause of Symptoms.

CONDITION	percent	n
Carpal Tunnel Syndrome	67	11
Repetitive Motion Disorder (Cumulative Trauma Disorder)	38	7
Repetitive Strain	38	7
Rheumatoid Arthritis	33	6
Nerve Entrapment	22	4
Degenerative Arthritis	17	3
Fracture or Sprain of the Forearm, Wrist, or Hand	17	3
Compression Neuropathy	11	2
Overuse Syndrome	11	2
Diabetes Mellitus	6	1
Anomalous Muscle	6	1
Nonspecific Tenosynovitis	6	1
Schleroderma	6	1
Lateral Epicondylitis	6	1
Obesity	6	1
Use of estrogen or oral contraceptives	6	1

Table 18. Diagnostic Tests Suggested/Used.

DIAGNOSTIC TESTS	percent	n
Nerve Conduction Study	61	11
X-ray of the wrist or hand	38	7
Grip and/or pinch strength	38	7
Dexterity Testing	33	6
Bone Scan	22	4
Two-point discrimination test	17	3
Magnetic Resonance Imaging	17	3
Other	17	3

Table 19. Treatments Experienced and Subjective Rating of Effectiveness.

TREATMENT RECEIVED	n	EFFECTIVE	% EFFECTIVE
Injection of Corticosteroids in or near any joint of the hand, wrist, or arm	9	5	56
Wrist/hand Splint	6	6	100
Strengthening Exercises	5	4	80
Professional Advice About Work Environment	3	2	67
Counseling Rregarding Work Postures	3	2	67
Carpal Tunnel Release	3	2	67
Hydrotherapy	3	2	67
Professional Adaptation of Tools	2	2	100
Vitamin B-6	2	1	50
Medication	1	1	100
Professional Advice on Work-rest Cycles	1	1	100

Table 20. Self-Treatments Used.

SELF-TREATMENTS	n	EFFECTIVE	% EFFECTIVE
Rest (hand and arm)	15	11	73
Over-the-counter Medication	14	10	71
Massage	12	9	75
Warm Soaks	7	7	88
Ice Packs	4	2	50
Alcoholic Beverages	3	1	33
Shake hands to increase blood flow	10	8	80
Adapt Tools	12	6	80
Change Work Posture	9	6	67
Change Work Habits	4	4	100
Ace Wrist Wrap	2	2	100
Change Jobs	6	2	33
Wear a Glove	4	1	25

Table 21. MOS X History of CTD.

MOS	N	PERCENTAGE	RISK RATIO	CONFIDENCE INTERVAL	P VALUE
DENTIST	14	7.1			
DENTAL ASST.	14	21.4	3.0	0.43 < RR < 25.46	0.60
SA_HYG	8	25.0	3.5	0.81 < RR < 32.80	0.53
DAEF	9	62.5	8.8	1.23 < RR < 62.34	0.01

Table 22. History of CTD X Symptoms.

SYMPTOM	History of CTD	PERCENTAGE	RISK RATIO	CONFIDENCE INTERVAL	P VALUE
NUMBER OF SYMPTOMS	0-4 (n = 11) ≥5 (n = 33)	24.20 81.90	3.4	1.74 < RR < 6.57	0.001
TINGLING	NO (n = 11) YES (n = 33)	33.30 72.70	2.2	1.12 < RR < 3.57	0.04
PAIN AT NIGHT	NO (n = 11) YES (n = 33)	33.30 72.70	2.2	1.19 < RR < 3.99	0.04
SENSATION OF FALLING ASLEEP	NO (n = 11) YES (n = 33)	27.30 72.70	2.7	1.37 < RR < 5.18	0.01
LOSS OF STRENGTH	NO (n = 11) YES (n = 33)	39.40 72.70	1.90	1.06 < RR < 3.22	0.06
DECREASED SENSATION	NO (n = 11) YES (n = 33)	18.2 72.7	4.0	1.78 < RR < 8.98	0.002
FREQUENT DROPPING	NO (n = 11) YES (n = 33)	18.2 72.7	4.0	1.78 < RR < 8.98	0.002
SWELLING	NO (n = 11) YES (n = 33)	21.2 81.8	3.9	1.89 < RR < 7.88	0.0006
STIFFNESS	NO (n = 11) YES (n = 33)	60.6 72.7	1.2	0.76 < RR < 1.89	0.72
NON-PRESCRIBED TREATMENT	NO (n = 33) YES (n = 11)	09.1 54.5	6.0	1.80 < RR < 20.50	0.004
CTS	NO (n = 33) YES (n = 11)	3.0 36.4	12.0	1.50 < RR < 96.28	0.01

Table 23. Comparison of Previous Studies.

STUDY	CTS	ONE OR MORE SYMPTOMS	BACK PAIN
Osborn, 1990	7.0%	63.0%	
Macdonald, 1988	6.4%		
Huntley, 1986*		54.0%	
Boyer, 1986**	.07%	1.6%	8.3%
Fauchard Academy, 1965***			33.3%
Rice, 1992	11.0%	75.6%	53.3%
dentists	7.1%	71.4%	42.9%
dental assistants	0.0%	71.4%	57.1%
SA_HYG	25.0%	88.9%	75.0%
DAEF	25.0%	75.0	50.0%

* As reported by Huntley, 1988.
** All respondents had two years work experience, 56% were 22-24 years old with a mean age of 26.
*** As reported by Boyer, 1986.

Table 24. Comparison of Symptoms Found in Other Studies.

SYMPTOMS	HUNTLEY, 1986	MACDONALD, 1988	RICE, 1992
Paresthesia	17.0%	33.2%	
Weakness		32.0%	46.7%
Night Pain	34.0%	28.0%	42.2%
Clumsiness		19.2%	31.1%
Numbness	21.0%		44.4%
Tingling	17.0%		44.4%

Table 25. Comparison of Symptoms in Subjects with Diagnosed, Versus Undiagnosed CTS.

FINGER/HAND SYMPTOMS	OSBORNE, 1990		RICE, 1992	
	Symptomatic	Diagnosed	Symptomatic	Diagnosed
Loss of strength	31.5	80.0	46.7	100.0
Shooting sensation or pain while working	30.9	80.0		
Tingling or numbness	29.3	96.0	44.4	100.0
Cold	26.7	44.0		
Clumsiness/dropping	23.1	68.0	31.1	80.0
Night pain	21.4	96.0		
Numbness on awakening	20.7	84.0		
Sensation of "falling asleep during normal activity			37.7	100.0
Stiffness			62.2	100.0
Decreased sensation			31.1	100.0
Morning swelling			35.6	60.00

Appendix A. Functions of Dental Workers

Dental Assistant Expanded Function:

Major duties: Perform a wide range of dental procedures under the direction of the dentist to include: restoring teeth prepared by the dentist with permanent and temporary fillings; places buses and liners, sealants, adapts and places matrices to normal and abnormal teeth; places, condenses, carves, finishes, and polishes amalgam restorations, including those involving grossly decayed teeth requiring cusp replacement and retentive pins; places, compresses, and finishes synthetic restorations including multi-surfaced anterior restorations; and places and contours temporary restorations. They also support the dentist in endodontic treatments by applying rubber dams, removing temporary fillings using low speed handpieces, and cleaning and drying operative field. After the dentist treats the patient, the DAEF may irrigate the tooth, apply prescribed medications, and close the tooth with temporary filling. Takes preliminary impressions for study models, modifying impression tray as needed. Pours and trims models. Constructs custom impression trays. Retracts gingiva from tooth for final impressions by placing and removing retraction cord. Selects, adapts and sets stainless steel crowns; constructs and cements temporary acrylic crowns and bridges, fabricates simple acrylic appliances. Assists in surgical treatment by applying and removing periodontal and post extraction dressings, and removing sutures. Performs the complete range of preventive dental measures to include prophylactic therapeutic procedures. Instructs patient in preventive dental care measures, general nutrition as related to dental health, the common causes of tooth decay, and the care of prosthedontic appliances. Applies desensitizing agents, tissue conditioners, and other topical agents prescribed by dentist to specified areas of the oral cavity. Operates dental X-ray equipment to take intra- and extra-oral radiographs. Provides chairside assistance, fully anticipating dentist's needs for various instruments, materials, and services. Performs other duties as assigned.

Dental Hygienist:

Serves as a dental hygienist responsible for administering oral prophylaxis, treating abnormal gum conditions, and instructing patients in oral health care. Performs complete oral prophylaxis including the following: seats and drapes patients; applies disclosing solution to the teeth; performs supragingival and subgingival scaling using cavitron and scalers to remove calculus deposits, accretions, prophylactic paste; and applies topical fluorides and other anticariogenic agents. Cleans and polishes removable dental appliances worn

by patients. Examines patient's oral cavity including the mouth, throat, and pharynx, and records conditions of the teeth and surrounding tissues. Refers patients to the dentist who have abnormalities such as cavities, defective fillings, suspicious growths, or periodontal disease. Applies desensitizing agents and other topical agents to treat abnormalities such as gingivitis and Vincent's infection. Instructs patients, individually and in groups, in proper oral hygiene care using materials such as teeth models, displays, slides, toothbrushes, dental floss, disclosing tablets, mirrors and phase microscope. Demonstrates proper techniques of brushing, flossing and use of perio aids and explains the common causes of tooth decay and its relationship to general diet. Instructs patients on the care of dental appliances. Instructs nurses and nursing assistants in oral health care techniques for bedridden, handicapped, disabled, and chronically ill patients. Takes, develops, and mounts oral X-rays including bite wing and panoramic. Interprets X-rays to determine areas of calculus deposits and periodontal involving the relationship of the teeth, etc. Selects, and arranges X-rays as teaching tool for viewing by patients. Records the number of patients treated and type of treatment administered. Changes and maintains instruments to insure working conditions. Cleans, sharpens, and stores instruments.

Appendix IIA. Revised MOS Classification X Condition.

CONDITION	MOS	PERCENTAGE	RISK RATIO	CONFIDENCE INTERVAL	CHI SQUARE VALUE	P VALUE
CTS	DENTAL ASST. DENTIST DAEF	05.3 06.7 25.0	 1.27 4.75	 00.09 < RR < 18.52 00.70 < RR < 32.16	 0.03 2.55	 *0.700 *0.150
BACK PAIN	DENTIST DAEF DENTAL ASST.	40.0 57.9 66.7	 1.45 1.67	 00.72 < RR < 02.91 00.81 < RR < 03.45	 1.07 1.89	 0.300 0.170
NON-PRESCRIBED TREATMENT	DENTIST DENTAL ASST. DAEF	00.0 21.1 41.7			 3.58 7.67	 *0.084 *0.001
HAND/WRIST SURGERY	DENTAL ASST. DENTIST DAEF	00.0 07.1 16.7			 1.33 3.21	 *0.440 *0.150
HISTORY OF CTD	DENTIST DENTAL ASST. DAEF	06.7 21.1 50.0	 3.16 7.50	 00.39 < RR < 25.38 01.04 < RR < 54.12	 1.38 6.52	 *0.250 *0.016
ARTHRITIS	DENTIST DENTAL ASST. DAEF	20.0 52.6 66.7	 2.63 3.30	 00.88 < RR < 07.89 01.12 < RR < 09.90	 3.78 6.01	 0.052 *0.019
PRIOR HAND/WRIST INJURY	DENTIST DAEF DENTAL ASST.	07.1 09.1 11.1	 1.27 1.56	 00.09 < RR < 18.05 00.16 < RR < 15.01	 0.03 0.15	 *0.690 *0.590
NUMBER OF SYMPTOMS (≥5)	DENTIST DENTAL ASST. DAEF	14.1 36.9 69.3	 2.58 4.85	 00.63 < RR < 10.53 01.28 < RR < 18.38	 2.07 8.43	 *0.140 *0.003

* Fisher Exact.

Appendix IIB. Revised MOS Classification X Symptoms.

SYMPTOM	MOS	PERCENTAGE	RISK RATIO	CONFIDENCE INTERVAL	CHI SQUARE	P VALUE
TINGLING	DENTIST	21.4				
	DENTAL ASST.	42.1	2.0	00.67 < RR < 03.69	01.55	*0.190
	DAEF	76.9	3.6	01.51 < RR < 08.56	08.32	0.003
NIGHT PAIN	DENTIST	28.6				
	DENTAL ASST.	36.8	1.3	00.47 < RR < 03.51	00.25	*0.450
	DAEF	69.2	2.4	01.07 < RR < 05.51	04.46	0.034
ASLEEP	DENTIST	14.3				
	DENTAL ASST.	31.6	2.2	00.57 < RR < 08.59	01.31	*0.230
	DAEF	69.2	4.9	01.67 < RR < 14.10	08.43	0.004
STIFF	DENTIST	50.0				
	DENTAL ASST.	63.2	1.3	00.69 < RR < 02.32	00.57	0.450
	DAEF	76.9	1.5	00.86 < RR < 02.80	02.01	*0.150
SENSATION DECREASE	DENTIST	14.3				
	DENTAL ASST.	31.6	2.2	00.57 < RR < 08.58	01.30	*0.023
	DAEF	53.8	3.8	01.14 < RR < 12.43	04.80	*0.037
FREQUENT DROPPING	DENTIST	00.0				
	DAEF	46.7			07.78	*0.005
	DENTAL ASST.	53.3			10.20	*0.002
SWELLING	DENTIST	07.1				
	DENTAL ASST.	42.1	5.9	01.24 < RR < 28.05	04.97	*0.030
	DAEF	61.5	8.6	02.11 < RR < 35.25	08.98	*0.004
STRENGTH LOSS	DENTAL ASST.	36.8				
	DENTIST	42.9	1.6	00.50 < RR < 02.72	00.12	0.170
	DAEF	69.2	1.9	00.95 < RR < 03.74	03.20	0.070

* Fisher Exact.

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